IMPROVEMENTS IN COTTON PRODUCTION

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CONTENTS.

PROBLEMS of cotton improvement have been studied intensively in the United States in recent years on account of the boll-weevil invasion. Entering Texas from Mexico about 1892, this destructive insect has spread gradually over the cotton-producing States, doing enormous damage and necessitating a general reorganization of agriculture, which is still in progress. In default of any measures for keeping the insect back, the possibilities of improvement of production were studied, as affording the best prospect of reducing the injuries or making good the losses that the weevil might inflict. Several lines of botanical investigation have been followed to the stage of practical application. Superior varieties of cotton have been developed and brought into use, cultural methods improved, and cotton growing extended into new regions, where the weevil does not exist or is able to do little damage.

Instead of the industry being ruined or the crop reduced by one-half or one-third, as had been expected, production has been maintained and even increased during the period of weevil invasion. The growing of cotton has been abandoned in a few of the more humid districts, where the crop was uncertain and was most exposed to weevil damage, but more cotton is grown in the drier regions of central and western Texas, and a new branch of the cotton industry has been developed in the irrigated valleys of California, Arizona, and New Mexico not reached by the boll weevil. Adaptation to new conditions of soil and climate has been studied in the Southwestern States, in addition to the changes of varieties and methods that the weevil has enforced in the older regions of production.

IMPROVEMENT OF COTTON VARIETIES.

Attention has been given to the plant characters as well as to the quality of the fiber. Cultural characters have been improved to give better adaptation to conditions of weevil-infested regions, so that larger crops have been secured than seemed possible in the early years of the weevil invasion, while the quality of the product has also advanced. A general impairment of the quality of the fiber in weevil-infested regions as well as reduced production at first seemed inevitable because there were no early varieties with fiber of good quality, but the new varieties now available produce superior fiber and at the same time are earlier and more productive than the varieties that were grown before the weevils arrived.

DESIRABLE CULTURAL CHARACTERS.

Cultural characters, as distinguished from fiber characters, are those that facilitate production by increasing the yield or reducing the cost of labor. The cultural characters that are now recognized as of most importance in weevil-infested regions are early and rapid setting of the crop on small, upright, single-stalk plants; resistance to disease, to insect pests, or to unfavorable conditions of growth; large bolls; and the holding of the cotton in the open bolls, the so-called "stormproof" character. To lack any of these features is a serious deficiency which has to be compensated, if at all, by some special quality or special adaptation to local conditions.

CHARACTERS THAT FACILITATE PICKING.

The boll and plant characters that facilitate picking are of special importance in the United States on account of the high wages of farm labor. In Arizona and California in 1920 it cost 4 cents a pound for picking Egyptian cotton, because the bolls are small, while Upland cotton was picked for 2 cents a pound. In some of the Upland varieties, as Lone Star, Holdon, and Tuxtla, a pound of seed cotton may be picked from 50 or 60 bolls, while more than a hundred bolls must be gathered for each pound of Egyptian cotton.

Apart from the boll characters it is easier to pick cotton from plants of upright habit and without vegetative branches to interfere with the movements of the pickers. It is difficult to move about in a field of tangled, overgrown cotton, and the bolls are harder to reach with the hand. In addition to these difficulties many bolls develop imperfectly and do not open well in fields of large, overgrown plants. It is one of the advantages of the Egyptian cotton in Arizona and California that the stalks are stronger and more upright, while the Upland varieties, and especially the Texas big-boll sorts, often bend over and become nearly prostrate when the plants grow large or fruit heavily. Picking is much more difficult in such fields, and many of the bolls rot or mildew, especially in wet weather.

VALUE OF SHORT-SEASON VARIETIES.

From Mexico and Central America new types of cotton have been secured with specialized characters that may be considered as weevil-resisting adaptations, but the chief factor of weevil resistance is the ability to set a good crop of bolls in a short period of time, early in the fruiting season. The weevils do not breed until the flower buds are formed, and a month or more must elapse before the weevil population is greatly increased. Hence, it usually is possible for a prolific early variety of cotton to set its bolls before the weevils become too numerous and destructive. When all of the flower buds are infested, no more bolls can be set.

It is only in dry weather that any setting of bolls can be expected later than the first month or six weeks after flowering begins unless the weevils can be controlled by methods of poisoning recently developed. In dry weather the infested buds fall off promptly and are soon shriveled in the hot sun, which kills the weevil larvæ. If the weevils survive the winter in excessive numbers even the early flower buds may be destroyed, but a crop may be set later if the weevil population is reduced by a period of dry weather, such as sometimes occurs in Texas. Hardy varieties of cotton that can continue to set fruit during dry weather, after the weevils have been reduced, are of special value in Texas, now the chief center of cotton production.

ADVANTAGES OF SMALL EARLY PLANTS.

In addition to planting early varieties, cultural precautions need to be observed in the interest of small size and early maturity of the plants. Even the earliest and most prolific varieties if forced into rank, luxuriant growth may grow into large late-maturing plants and yield only small crops. The advantage of small plants is not limited to weevil-infested districts or even to short-season conditions. The rule is that small upright plants, close together in the rows, are better than large spreading plants for purposes of production. Very large crops can be raised on relatively small plants, not more than 3 feet high with Upland cotton or 4 feet high with Egyptian cotton. Larger growth of the plants does not promise a larger yield, but is more likely to reduce the yield, through blasting and shedding of buds and young bolls. Plants that are too large and luxuriant may fail to set any bolls or may put on a late crop of bolls, to be destroyed by an early frost. Crowding between the rows, as in fields of large, spreading plants, shuts out the light and interferes with the development of an early crop, which must be borne near the ground on the lower fruiting branches of the main stalk of the plant, not on branches that develop late in the season.

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SUPPRESSION OF VEGETATIVE BRANCHES.

For a clear understanding of cultural problems it is necessary to take account of the structure of the cotton plant, with its specialized habits of branching. In technical language the branches are dimorphic, or of two different forms, distinguished as fruiting branches and vegetative branches, the latter functioning as secondary stalks and developing from the base of the main stalk, below the fruiting branches. Vegetative branches are more numerous on large plants and often replace the lower fruiting branches. Usually the vegetative branches are confined to the lowest joints of the main stalk, below the sixth or seventh joint, while fruiting branches usually begin at the seventh, eighth, or ninth joint, though sometimes not till the twelfth joint, or above. In extreme cases of luxuriance all of the fruiting branches may be replaced by vegetative branches, and the plants produce no fruit, though growing to enormous size.

As a means of securing early crops of cotton in the presence of the boll weevil or in short seasons, it is better cultural practice to have large numbers of small plants than small numbers of large plants. Vegetative branches are not desirable for purposes of production. After the structure of the plant was studied and the two kinds of branches were recognized as distinct, it became possible to devise very simple and effective methods of suppressing the vegetative branches by keeping the young plants closer together. With deferred thinning and close spacing in the rows most of the plants develop with a single upright stalk. With rows 36 to 42 inches apart the largest crops are produced from single-stalk plants less than a foot apart in the row, not from wide-spreading plants 2 or 3 feet apart. The single-stalk system avoids crowding between the rows and secures a more normal development of the lower fruiting branches, where the early bolls are produced.

IMPROVEMENT OF FIBER QUALITY.

Short cotton is essentially inferior for spinning because the fibers do not hold strongly together. The threads tend to ravel and come apart, and the fabrics are less durable than those that are made from long staples. Much effort has been applied in the last half century to the improvement of machinery to extend the use of short cotton in the direction of finer spinning, to replace long staples, while the growing of better cotton has been neglected and resources of production are only partially utilized. Short and inferior fiber is produced in many regions where cotton of much better quality and higher commercial value could be grown. Farmers get low prices for their cotton, manufacturers are supplied with inferior raw materials, and

the public buys weaker and less durable fabrics as the result of the little regard paid to the essential wastefulness of the present system.

A reaction away from the shortest and most inferior fiber is now in progress. Higher wages in cotton mills have led to a reduced demand for very short low-grade cotton, which carries more dust and trash and is more difficult to spin and weave because the threads break more frequently. Operatives prefer to work in mills that use longer and cleaner cotton, of inch staple or better. Distinct premiums are being paid in some markets for $1\frac{1}{8}$-inch staple, or even for $1\frac{1}{16}$, which formerly had to be sold with ordinary short cotton. As a striking example, premiums of 12 and even 14 cents a pound were paid on $1\frac{1}{8}$-inch staple at Clarksville, Tex., in October, 1920. With Lone Star fiber selling at 33 to 35 cents, Triumph or Mebane cotton, which runs about one-sixteenth of an inch shorter, sold at 21 cents. But in other parts of Texas, away from long-staple markets, Lone Star cotton had an advantage of only 2 or 3 cents above Mebane and Rowden.

The United States Department of Agriculture has bred and distributed a series of varieties of cotton which are adapted to a wide range of conditions in the American cotton belt and are superior in length and abundance of lint, as well as being early and prolific. The Lone Star variety produces under favorable conditions $1\frac{1}{8}$-inch staple, the Acala variety $1\frac{3}{16}$ inch, the Columbia and Durango $1\frac{1}{4}$ inch. In carefully conducted tests these varieties have often outyielded other sorts with much shorter fiber. Even the Meade cotton, producing $1\frac{5}{8}$ to $1\frac{3}{4}$ inch staple of Sea Island quality, yields as much as some of the short-staple varieties that are grown in the same districts in Georgia and South Carolina.

With such varieties available, no agricultural reasons can be alleged for continuing to produce cotton of less than inch staple in the United States, nor do there appear to be any industrial or general economic reasons for holding to the short and inferior fiber that still forms a large proportion of the American cotton crop. Only the commercial reason can be given, that buying cotton from the farmers with no adequate discrimination of quality tends to keep production on a low plane. Not only resources and labor of production are wasted in being applied to inferior varieties and mongrel seed stocks, but enormous industrial and economic wastes are involved in the manufacture and use of weaker and less durable fabrics.

UNIFORMITY AS A FACTOR OF IMPROVEMENT.

On account of the textile uses of cotton there is a fundamental need of uniformity in the length, strength, and spinning quality of the fiber. Weak fiber breaks in spinning, and fine spinning can not be done with fiber of mixed lengths. On account of the failure in the past to develop and maintain adequate supplies of pure seed, a large

part of the American cotton crop is raised from inferior mixed stocks, and the fiber is not of the uniform quality that can be produced from pure-bred varieties. The practical use of selection is not limited to the development of new varieties. It is equally important to preserve and maintain the uniformity of superior varieties during the period of production.

Lack of uniformity in the seed stocks not only renders the fiber of less value for spinning, but tends to reduce the crop. Many degenerate plants are to be found in mixed fields, some of them very abnormal to the extent of being completely sterile or of failing to open their bolls before frost, while others that have very short or sparse lint may produce an abundance of seed to contaminate the stock. On account of the smaller yields and the lower value of mixed fiber, the lack of uniform seed stocks of superior varieties results in lower efficiency of production, estimated at 20 or 30 per cent. If other possibilities of improvement are considered in cultural methods and in the handling and marketing of the crop, it may be found that the former system of production did not have more than a 50 per cent efficiency. Thus, the study of the different problems has revealed a very wide margin of possible improvement to compensate the losses that were threatened by the boll weevil.

ADAPTATION TO NEW CONDITIONS.

In addition to the changes of varieties and methods that the boll weevil has enforced in the older regions of production, adaptations of the different varieties and types of cotton have been studied under new conditions of soil and climate in the Southwestern States. Although many varieties show striking responses to new conditions, with very abnormal behavior in the first years, it is possible, with many varieties, to secure a high degree of adjustment to the new conditions, with normal and regular behavior of the plants, after a few years of acclimatization or local adjustment, assisted by a proper course of selection.

The range of adaptive possibilities is strikingly shown when a new type of cotton, distinct from any formerly grown in the United States, is able to thrive under many different conditions in widely separated regions. Thus, the Durango, a new Upland cotton, introduced only a few years ago from Mexico and acclimatized in Texas, has shown its ability to produce large crops of good fiber over almost the entire range of cotton cultivation in the United States. The Acala cotton, more recently acclimatized from southern Mexico, is even more resistant to extremes of dry weather and to short-season conditions. The wide range of adaptations shows that production may be standardized on the basis of a few important commercial types, with locally selected strains and differences of conditions to

be recognized, but with no need of such numbers and diversities of local stocks as formerly existed, before the weevils put an end to many of the older varieties.

ADAPTATION TO SPECIAL CONDITIONS.

Though many varieties grow and produce crops under a wide range of conditions, there are definite limiting factors that govern the choice of varieties for particular regions. Thus, the Egyptian type of cotton, though well adapted to the hot, dry, irrigated valleys of Arizona and California, is excluded from Texas and the eastern cotton belt by long-season requirements and by greater susceptibility to the black-arm, or angular leaf-spot disease. Black-arm is a disease of very general occurrence, but Upland and Sea Island cotton usually escape serious injury, while Egyptian cotton suffers much under the eastern United States conditions. Most of the leaves fall early in the season, and in severe cases the stalks are girdled and break off. The involucres also are attacked. the buds blasted, and the bolls injured, even in later stages of development.

In the southwestern valleys the Egyptian cotton usually shows very little injury from black-arm and has a distinct advantage over Upland varieties in less shedding of buds and young bolls in hot weather or when irrigation is delayed. By virtue of holding its crop better the Egyptian cotton in the Southwest often yields more heavily than adjacent fields of Upland cotton, a result that is entirely at variance with the popular idea that short-staple varieties are more productive.

The cultivation of Sea Island cotton in the Southeastern States has been abandoned in the last few years because too long a season is required to produce a crop, which means extra exposure to weevil injury. A new long-staple Upland variety, called Meade, with fiber remarkably similar to Sea Island cotton in quality and length of staple and yielding two or three times as much under weevil conditions. is replacing the Sea Island type in Georgia and South Carolina.

The idea that the Sea Island or the Meade cotton might be grown in the Southwest instead of Egyptian cotton has naturally suggested itself, but neither of these long-fiber types has shown promise in the irrigated valleys where the Egyptian cotton thrives. The plants do not refuse to grow, but usually the crops are small, the bolls do not open well, and the fiber is weak. The Sea Island cotton has also shown greater susceptibility to the leaf-cut disorder (tomosis) than any of the Upland or Egyptian varieties in the Arizona experiments.

Even the short-staple Upland varieties from the Southeastern States have not proved well adapted to conditions in Texas, Arizona, and California. The southeastern varieties are supposed to have come from the West Indies, or some of them possibly from the Old World.

their histories being obscure, but they are distinct from the Mexican and Central American types of Upland cotton, including the Texas big-boll type, which came in after the war with Mexico. As a result of repeated comparisons in many localities for more than a decade, greater resistance to drought or other unfavorable conditions may be claimed for the Mexican and Central American types, and they seem likely to displace the eastern short-staple varieties.

IMPROVEMENT OF SEED SUPPLIES.

Supplies of pure seed are an elementary requirement almost completely neglected in the past, but now recognized as one of the chief essentials of improvement in cotton production. Obviously, it is impossible to utilize a superior variety of cotton unless seed is available in large quantities and of uniform quality. A mixed, degenerate seed stock does not represent the productive possibilities of a variety. The farmer gets a smaller crop and must sell it at a lower price, while the manufacturer must use inferior raw material. The popular belief that varieties of cotton "run out" rapidly and need to be replaced by other sorts after a few years is erroneous and misleading in view of the fact that some of the best varieties have been grown in the same districts for many years without deterioration in quality or productiveness. As long as selection is maintained and the seed is not mixed at public gins or crossed with other varieties in the field, the variety will not deteriorate.

ONE-VARIETY COTTON COMMUNITIES.

In order to insure the production of adequate commercial quantities of pure seed of superior varieties of cotton, the select stocks must be planted in separate communities, apart from other varieties. Small stocks of pure seed can be protected by special precautions for isolating the fields and thorough cleaning of the gin machinery, but these precautions are difficult to maintain, and experience has shown that it is practically impossible to keep two or more varieties apart in the same community. Although cotton pollen is not spread by the wind, different varieties raised in adjacent fields may show large numbers of hybrids, the pollen being carried by insects from one field to another. Moreover, this mixing of varieties does not stop at the field, but is continued at the public gin, where the residue of seed from each farmer's ginning goes in with the next lot. Mixing, crossing, and deterioration of varieties are avoided in communities that restrict themselves to a single superior sort.

The larger the community or district that is organized for one-variety production, the greater is the commercial advantage. Assurance of adequate supplies of uniform staple being maintained is the best inducement that can be given to manufacturers to buy and

use a particular kind of cotton. Labor problems, ginning, warehousing, and financing the crop are undertaken more readily in communities that deal with a standardized product, and even the field operations of production are facilitated and made more effective by community organization.

IMPROVEMENT OF COMMUNITY ORGANIZATION.

Communities that unite upon a single superior variety of cotton and maintain a supply of pure seed find that many of their problems are simplified and that many avenues of progress are opened. More definite knowledge and more practical skill can be developed in the handling of one kind of cotton than in mixed communities, where information is uncertain and discussion is often unprofitable, because each farmer may have in mind a different kind of cotton, to which his success or failure is ascribed. This confusion of ideas is avoided in one-variety communities, so that the farmers learn how to interpret the behavior of the plants in relation to soil, weather, cultivation, irrigation, or other conditions that need to be controlled or taken into account in the handling of the crop.

Other community improvements, cultural precautions, insect or disease control, labor supplies, ginning, handling, warehousing, financing, and marketing of the crop are all approached to greater advantage in organized one-variety communities. Planting all of the cotton as nearly as possible at the same time is a measure of protection against weevil injury, and the other weevil precautions of dusting poison on the plants and clearing the fields in the fall undoubtedly are more effective if used by entire communities than if applied by scattered, individual farmers.

IMPROVEMENT OF THE COMMERCIAL SYSTEM.

The organization of one-variety communities opens the way to a gradual improvement of the commercial system, which in unorganized communities tends seriously to discourage progress. The individual farmer who plants a better variety than his neighbors but finds himself unable to get a higher price in the market has no inducement to observe the precautions that are necessary to keep the seed from being mixed or to keep his bales from being "plated" at the gin with the inferior fiber that his neighbor grows. No doubt it seems good business to buy cotton from farmers at short-staple prices and sell to manufacturers at long-staple prices, but certainly such dealings do not tend to the improvement of production. The effect is to penalize the progressive farmer and to encourage the careless farmer to go on being careless.

A way must be opened for the higher prices that the manufacturers pay for good fiber to get back to the farmer if premiums are to stimu-

late the production of better cotton in the way that demand is supposed to react upon the supply. When the buyers absorb the premium the demand can not be said to have reached the farmer, and the supply is not affected except adversely. A farmer who sends his long-staple cotton to New Orleans and gets more than twice as much as any of the local buyers would offer him has little confidence in the home market.

Manufacturers who are interested in improved production should understand the need of effective encouragement of farmers by adequate discrimination in prices and cooperation with one-variety communities. The best that can be done under the present system is to sort over the product of many mixed communities into the so-called "even-running" lots that the manufacturers buy. After a mixed crop has been produced and assembled at the large shipping points an effort is made in the direction of uniformity. Manufacturers rely upon classing and mill tests to avoid the bales that have the worst mixtures of fiber, but the entire crop of mixed communities is inferior. Selection can be applied much more effectively to plants in the field than to bales of cotton. Separation of short fibers from long-staple cottons by the process of combing is slow and expensive, so that manufacturers can afford to pay much higher prices for uniform fiber than for the usual mixed crop raised from ordinary "gin-run" seed. Manufacturers understand the need and the value of uniformity in cotton fiber and are in the best position to appreciate the uniform product that one-variety communities can furnish.

Differences of quality and condition of the fiber will still be recognized, of course, in community production. Poor soils or bad seasons, carelessness in cultivation, irrigation, picking, or ginning will have their effects, but community organization will make it easier to deal with such differences in progressive ways. The best opportunity of judging the quality of the fiber is in the field before the cotton is picked. Field inspection is practicable in one-variety communities and would be a great improvement over the present system of commercial classing, not only in enabling the manufacturer to obtain much more uniform fiber, but in applying the just discrimination in prices that would encourage the farmer to use the best seed and take the best care of his cotton.

The present commercial system, through discouraging good farming and keeping the cotton industry on a low plane of development, may be considered responsible for the prevailing idea that the growing of cotton is a proper employment for cheap and careless labor. A clear understanding of the problems and possibilities of cotton culture among manufacturers and commercial leaders would make plain the need of enlisting the best intelligence and skill through just remuneration for improved production.

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